

CLAIMS

1. In a system wherein at least two sources of electric power are connected in parallel, each source of electric power having associated with it a regulator, each regulator for producing a regulating signal for its associated source of electric power, one of the regulators being a master regulator and at least one of the regulators being a follower regulator, a method for controlling the sources of electric power comprising:

- sensing an output of a source of electric power;
- generating a control signal with the master regulator based on the sensed output;
- generating a regulating signal with the master regulator based on the control signal for a source of electric power associated with the master regulator;
- sensing at least one operational characteristic of at least one source of electric power;
- modifying the control signal with the master regulator based on the operational characteristic of the source of electric power;
- sending the modified control signal from the master regulator to the follower regulator; and
- generating a regulating signal with the follower regulator based on the modified control signal, the regulating signal for the source of electric power associated with the follower regulator.

2. The method of claim 1, wherein the sources of electric power comprise alternators producing power from at least one source of motive power; and

wherein sensing an output of a source of electric power comprises sensing with the master regulator an output of an alternator associated with the master regulator.

3. The method of claim 1, wherein the sources of electric power comprise alternators producing power from at least one source of motive power;

wherein sensing at least one operational characteristic of at least one source of electric power comprises sensing with the master regulator at least one operational characteristic of an alternator associated with the master regulator; and

wherein modifying the control signal comprises modifying the control signal based on the operating characteristic of the alternator associated with the master regulator.

4. The method of claim 3, wherein modifying the control signal comprises normalizing the control signal.

5. The method of claim 3, wherein modifying the control signal comprises converting the control signal to an instruction representing a percentage of maximum output of the alternator associated with the master regulator.

6. The method of claim 5, wherein converting the control signal is based on a look-up table.

7. The method of claim 5, wherein generating a regulating signal with the follower regulator comprises generating a regulating signal so that an alternator associated with the follower regulator produces the percentage of maximum output.

8. The method of claim 7, further comprising sensing by the follower regulator an operating characteristic of the alternator associated with the follower regulator; and

wherein generating a regulating signal with the follower regulator is based on the modified control signal and on the operating characteristic of the alternator associated with the follower regulator.

9. The method of claim 1, wherein the sources of electric power comprise master and follower alternators producing power from at least one source of motive power;

wherein sensing at least one operational characteristic of at least one source of electric power comprises sensing the operational characteristics of the master and follower alternators; and

wherein modifying the control signal with the master regulator comprises generating a modified control signal based on the operational characteristics of the master and the follower alternators.

10. The method of claim 9, wherein modifying the control signal comprises:

determining efficiency of the alternator associated with the master regulator;

determining efficiency of the alternator associated with the follower regulator;

modifying the control signal based on the efficiency of the alternator associated with the master regulator and based on the efficiency of the alternator associated with the follower regulator.

11. The method of claim 9, wherein modifying the control signal comprises:

determining operation life of the alternator associated with the master regulator;

determining operation life of the alternator associated with the follower regulator; and

modifying the control signal based on the operation life of the alternator associated with the master regulator and based on the operation life of the alternator associated with the follower regulator.

12. The method of claim 1, wherein the operating characteristic comprises operating temperature of at least one of the sources of electric power.

13. The method of claim 12, wherein the operating characteristic further comprises speed of at least one of the sources of electric power.

14. In a system wherein at least two sources of electric power are connected in parallel, each source of electric power having associated with it a regulator, each regulator for producing a regulating signal for its associated source of electric power, one of the regulators being a master regulator and at least one of the regulators being a follower regulator, a method for controlling the sources of electric power comprising:

- sensing an output with the master regulator of a source of electric power;
- generating a control signal with the master regulator based on the sensed output;

- generating a regulating signal with the master regulator based on the control signal, the regulating signal for regulating the source of electric power associated with the master regulator;

- determining a percentage of maximum output for the source of electric power associated with the master regulator;

- sending a instruction representing the percentage of maximum output from the master regulator to the follower regulator; and

- generating a regulating signal with the follower regulator based on the signal from the master regulator, the regulating signal for producing the percentage of the maximum output for the source of electric power associated with the follower regulator.

15. The method of claim 14, wherein the sources of electric power comprise alternators producing power from at least one source of motive power; and

- wherein determining a percentage of maximum output for the alternator associated with the master regulator comprises:

- sensing at least one operational characteristic of the alternator associated with the master regulator; and

- determining the percentage of maximum output from a look-up table based on the control signal and the operational characteristic.

16. The method of claim 15, wherein generating a regulating signal with the follower regulator based on the signal from the master regulator comprises:
sensing at least one operational characteristic of the alternator associated with the follower regulator; and
generating the regulating signal from a look-up table based on the signal from the master regulator and the operational characteristic.

17. A power system for producing electrical power comprising:
at least two sources of electric power connected in parallel, the sources of electric power individually responsive to an associated regulating signal;
at least two voltage regulators comprising:
a master voltage regulator for producing a control signal in response to variations in voltage at an output of the source of electric power associated with the master regulator, for producing a regulating signal to the associated source of electric power, and for sending a follower regulator signal based on the control signal and based on at least one operating characteristic of the source of electric power associated with the master regulator; and
at least one follower regulator for receiving the follower regulator signal, and for producing a regulating signal for its associated source of electric power based on the follower regulator signal and based on at least one operating characteristic of the source of electric power associated with the follower regulator.

18. The power system of claim 17, wherein the sources of electric power comprise alternators producing power from at least one source of motive power;
further comprising an energy storage device; and
wherein the alternators are connected in parallel across the energy storage device.

19. The power system of claim 17, wherein the energy storage device comprises a battery.

20. The power system of claim 17, wherein the at least one operating characteristic comprises temperature and speed.

21. The power system of claim 17, wherein the regulating signal for the source of electric power associated with the master regulator operates the source of electric power associated with the master regulator at a percentage of maximum output; and

wherein the follower regulator signal is based on the percentage of the maximum output.

22. The power system of claim 21, wherein the regulating signal for the alternator associated with the follower regulator operates the alternator associated with the follower regulator at the percentage of the maximum output.

23. In a system wherein at least two sources of electric power are connected in parallel, each source of electric power having associated with it a regulator, each regulator for producing a regulating signal for its associated source of electric power, a method for controlling the sources of electric power comprising

determining which regulator is a master regulator after power-up of the system;

sensing an output of at least one of the sources of power;

generating, by the master regulator, a control signal to control its associated source of electric power;

sending a signal to a follower regulator based on the control signal;

generating, by the follower regulator, a regulating signal for a source of electric power associated with the follower regulator based on the at least one signal.

24. The method of claim 23, wherein determining which regulator is a master regulator after power-up of the regulators comprises sending a

communication from one regulator to another regulator to determine which regulator is a master regulator.

25. The method of claim 24, wherein sending a communication comprises arbitrating between the regulators to determine which regulator is the master regulator.

26. The method of claim 24, wherein sending a communication from one regulator to another regulator to determine which regulator is a master regulator comprises sending by the one regulator to all remaining regulators a message declaring the one regulator as the master regulator.

27. The method of claim 24, wherein determining which regulator is a master regulator comprises determining which regulator first sends a communication declaring itself the master regulator.

28. The method of claim 23, wherein the sources of electric power comprise alternators producing power from at least one source of motive power; and

wherein determining which regulator is a master regulator is based on location of the alternator associated with the regulator.

29. The method of claim 23, wherein determining which regulator is a master regulator is based on voltages measured by the regulators.

30. The method of claim 29, wherein a highest voltage measured by a regulator is determined to be the master regulator.

31. The method of claim 29, wherein determining which regulator is a master regulator is further based on a random number generator.

32. The method of claim 23, wherein determining which regulator is a master regulator comprises statistically analyzing voltages measured by the regulators.

33. The method of claim 23, further comprising determining, for a second time, which regulator is the master regulator.

34. The method of claim 33, wherein determining, for a second time, which regulator is the master regulator is performed a predetermined amount of time after the step of determining which regulator is a master regulator after power-up or is performed if a predetermined set of conditions are met.

35. The method of claim 24, further comprising accessing software to determine whether the one regulator is the master regulator.

36. A voltage regulator having functionality as a master regulator and as a follower regulator comprising:

a processor;

a communication interface in communication with the processor;

memory in communication with the processor; and

programming code stored in the memory for determining whether the voltage regulator operates as a master regulator or as a follower regulator.

37. The voltage regulator of claim 36, wherein the programming code comprises instructions for sending a communication via the communication interface to a second regulator regarding determining which regulator is the master regulator.

38. The voltage regulator of claim 36, wherein the programming code comprises instructions for arbitrating between the regulator and a second regulator to determine which regulator is the master regulator.

39. The voltage regulator of claim 38, wherein the programming code comprises instructions for a random number generator.

40. The voltage regulator of claim 36, further comprising a switch, and

wherein the programming code comprises instructions for accessing the switch to determine whether the voltage regulator operates as a master regulator or as a follower regulator.

41. The voltage regulator of claim 36, wherein the programming code comprises a constant value for determining whether the voltage regulator operates as a master regulator or as a follower regulator.

42. The voltage regulator of claim 36, further comprising:
programming code comprising instructions for functioning as a master regulator; and
programming code comprising instructions for functioning as a follower regulator.

43. The voltage regulator of claim 42, wherein the programming code comprising instructions for functioning as a master regulator comprises:
programming code comprising instructions for sensing an output of at least one alternator;
programming code comprising instructions for generating a control signal based on the sensed output;
programming code comprising instructions for generating a regulating signal for an alternator associated with the master regulator based on the control signal;
programming code comprising instructions for generating a message to be sent to a follower regulator based on the control signal; and
programming code comprising instructions for sending the message through the communication interface.

44. The voltage regulator of claim 43, wherein the programming code comprising instructions for functioning as a follower regulator comprises:
programming code comprising instructions for receiving the message through the communication interface; and

programming code comprising instructions for generating a regulating signal for an alternator associated with the regulator based on the message received.

45. In a system wherein at least source of electric power are connected in parallel, each source of electric power having associated with it a regulator, each regulator for producing a regulating signal for its associated source of electric power, wherein the improvement comprises:

code in the memory of the regulator for functioning as a master regulator;

code in the memory of the regulator for functioning as a follower regulator; and

means for determining whether the regulator is the master regulator or follower regulator, wherein a regulator may function as a master regulator or a follower regulator.

46. The improvement as claimed in claim 45, wherein the code for functioning as a master regulator comprises code for generating at least one signal to send to a follower regulator and sending the signal to the follower regulator.

47. The improvement as claimed in claim 46, wherein the sources of electric power comprise alternators producing power from at least one source of motive power; and

wherein the code for functioning as a follower regulator comprises code for receiving the signal from the master regulator and generating a regulating signal based on the signal from the master regulator for controlling an alternator associated with the follower regulator.

48. The improvement as claimed in claim 45, wherein the means for determining comprises code for arbitrating among regulators to determine which regulator is the master regulator.

49. In a system wherein at least two sources of electric power are connected in parallel, each source of electric power having associated with it a regulator, each regulator for producing a regulating signal for its associated source of electric power, one of the regulators being a master regulator and at least one of the regulators being a follower regulator, a method for controlling the sources of electric power comprising

sensing an output of at least one of the sources of electric power;

generating a control signal with the master regulator based on the sensed output;

generating a regulating signal with the master regulator for the source of electric power associated with the master regulator based on the control signal;

sending a message from the master regulator to the follower regulator based on the control signal; and

determining with the follower regulator whether to control a source of electric power associated with the follower regulator based on the message sent from the master regulator.

50. The method for controlling alternators in claim 49, wherein the sources of electric power comprise alternators producing power from at least one source of motive power; and

wherein determining whether to control a source of electric power associated with the follower regulator based on the message sent from the master regulator comprises sensing an output with the follower regulator of the alternator associated with the follower regulator.

51. The method for controlling alternators in claim 50, wherein determining whether to control an alternator associated with the follower regulator based on the message sent from the master regulator further comprises:

generating a follower control signal with the follower regulator based on the output sensed by the follower regulator; and

comparing the follower control signal with the message sent from the master regulator.

52. The method for controlling alternators in claim 49, wherein determining whether to control a source of electric power associated with the follower regulator based on the message sent from the master regulator comprises rejecting the message from the master regulator; and

further comprising:

sensing an output with the follower regulator of the source of electric power associated with the follower regulator;

generating a follower control signal with the follower regulator based on the output sensed by the follower regulator; and

generating a regulating signal with the follower regulator for the source of electric power associated with the follower regulator based on the follower control signal.